

## Building on Embedded Linux For High Availability



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SOFTWARE

*Powering the Embedded Revolution*

Embedded Systems Conference-China  
(ESC-China 2003)  
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## Agenda

- High Availability Applications
- High Availability Attributes
- Features of a High Availability Linux product

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## Why Embedded Linux for HA applications



- **Powerful Operating**
  - High performance OS delivering real time responsiveness and carrier-grade performance
  - Support for High Availability Hardware Platforms commonly used in Communications applications
  - Support for small footprints, boot from flash, etc
  - Complete and comprehensive binary and source-based embedded OS and Development platform
  - Rich, native TCP/IP stack, APIs, utilities
  - Robust, scalable applications platform
- **Open Source and Royalty Free**
  - No costly source code licenses – simple cost structure
- **Easy transition from legacy OS / RTOS**
  - Solaris/AIX/other UNIX on shelf
  - WRS pSOS/VxWorks on line cards/blades

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## Linux Value Proposition

### Linux and Open Source Software (OSS)

Fast Innovation

Leading Technologies

Standard Software and HW platforms

### Key Technologies

- Realtime <1millisecond
- Outstanding IP support
- Fast Reboot and Hot Swap
- On Line Tools and Debuggers
- Fault management

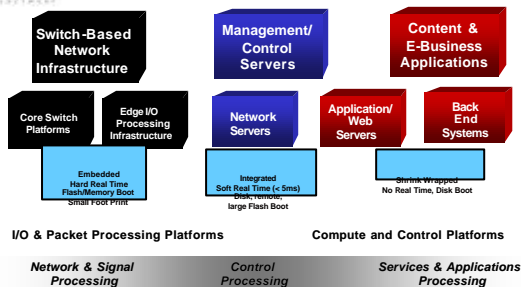
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## Embedded Linux Application Usage in Telecom



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## Example Applications that require Linux HA

### Management Servers

- Handle traditional network management operations as well as service management and customer management.
- Data and communication intensive.
- Response time requirements are less stringent by several orders of magnitude

### Gateways

- Maintains a large number of connections in real time over a large number of interfaces
- Implemented on dedicated platforms with replicated systems used for redundancy.

### Signaling Servers (Control)


- Handle call control, session control, and radio resource control.
- Handles the routing and maintains the status of calls over the network.
- Require soft real time response capabilities of less than 80 milliseconds
- Manages tens of thousands of simultaneous connections.

Context switch and memory intensive

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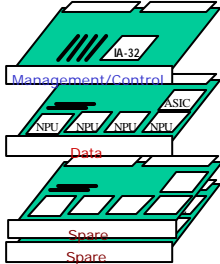
## Telecom Design Scenario

### Management / Control

- Manage Chassis, Hot Swap
- Host Fault-Management M/W
- Serve Blade boot images
- Manages availability of nodes
- Requires an Event and Resource Manager
- Hardened Kernel / Drivers
- Requires some real-time

### Data Plane


- Low-level packet-forwarding code
- Switching, routing
- I/O and routing performance
- Need to bring nodes back quickly and manage node failover
- Bonded Ethernet
- Quick boot time



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## HA and Carrier Grade Linux


Carrier Grade Linux is enhanced Linux that contains features to address key areas of Carrier Class solutions

- Performance and Scalability
- High Availability
- Serviceability
- Tools
- Standards


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## High Availability Architecture



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## HW High Availability

### Hardware/Software Redundancy

- RAID1 - and Disk Hot Swap
- Redundant Ethernet
- Hot Swap
- PICMG 2.12
- PICMG 2.9
- PICMG 2.16
- PICMG 3.0

### Event Notification

- Event Broker / Kernel messaging
- Event Logging

### Patching and Upgrading


- Patching and Upgrading

### Resource Monitoring

- Resource Monitoring

### Recovery


- Rapid Reboot
- Journaling
- Force Recovery (FS Unmount etc.)
- Watchdog



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## Other High Availability Features of Embedded Linux

- Device Driver Hardening
- Watchdog Timer Support
- Ethernet Link Aggregation
- Ethernet Link Failover
- RAID 1 Support
- Resilient File System Support
  - Journaling and Forced unmount of file systems
- Disk and Volume Management

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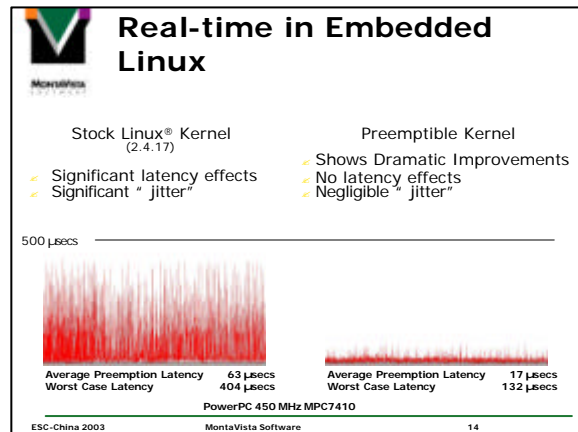
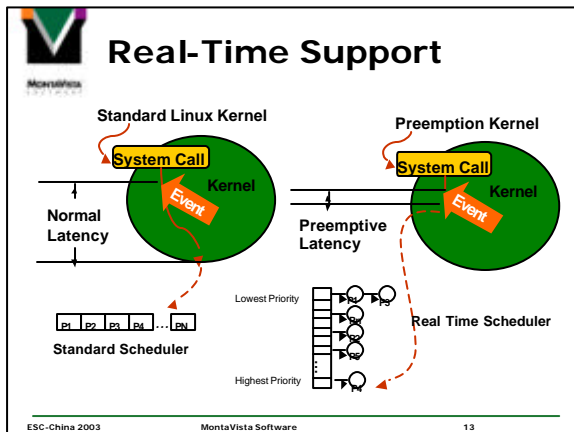
## Embedded Linux Real Time

- Real Time Preemptible Kernel
  - Provides a stable standard real-time solution
  - Preserves Linux programming model User-level applications and Standard APIs
  - Developed by MontaVista Software
  - Included as standard part of 2.5 Linux Kernel
- Fixed priority scheduler
  - Run in front of standard scheduler
  - Fixed overhead
  - Implements 128 priorities for pthreads
  - Enforce scheduling policies

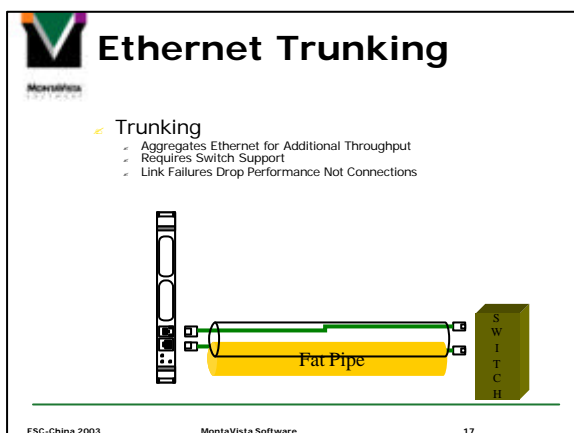
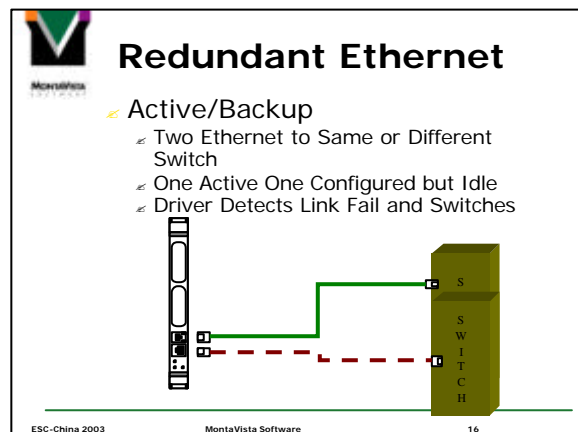
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- ## POSIX Standards Interface compliance
- Important for Application porting/migration
    - Microsecond Timers
    - Event log
    - Signaling and Message Queues
    - POSIX threads
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- ## Tools and Diagnostics
- Integrated Development Environment
  - Target Configuration
  - Application-Safe debugger and patcher
  - Library Optimization (LOT)
  - Linux Trace Toolkit
  - Kernel Real-Time latency Tools
  - Crash Core Analysis Suite
  - Kernel dump and analysis
  - In-Memory Core Dump (MCORE)
  - Support for Multi-threaded Core Dump
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## Online Debugging and Patching

- Standard debuggers are too invasive to use in live systems
- Strong need for non-intrusive field debugging
- Allows a debugger to be linked into an application without the application being aware
- The application can be delivered to the field with the debugger linked in
- Analyst can log in to the debugger, set tracepoints, and then log out
- The debugger will collect the information, and store it
- Runtime Application Patching allows changes to be applied to an application while it is running
- Bug fix no longer requires an upgrade

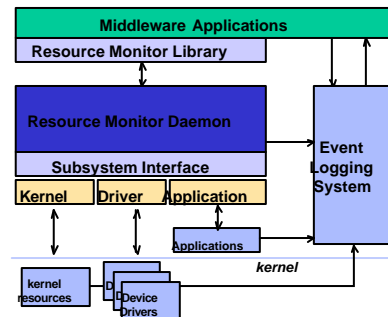
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## Resource Monitoring



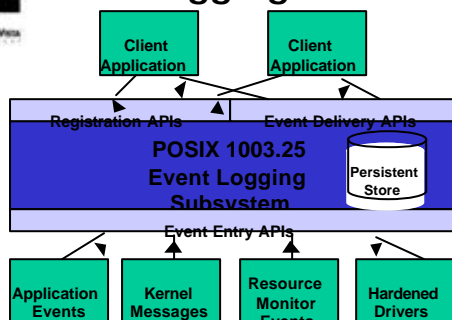
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## Event Logging



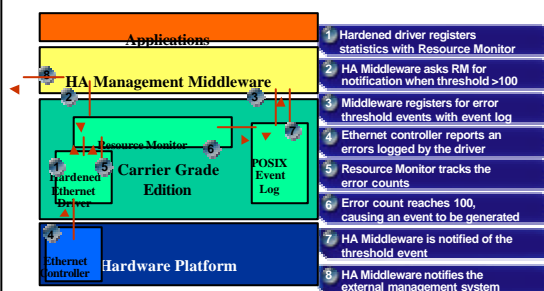
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## High Availability Scenario



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## Summary of Embedded Linux Features for HA



- Complete OS features
  - Real time performance
  - Scalability enhancements
  - Extensive selection of networking components
  - Hot swap and redundancy
  - Redundant Ethernet
  - POSIX compatible interfaces
- Development Environment
  - Profiling tools
  - Memory leak detection tools
  - System and user-level event tracing
  - Tools for generating and sizing target filesystems
- System Serviceability
  - Online and off-line diagnostics
  - Resource Monitoring and event logging
  - Kernel message monitoring
- Rich Tools
  - Field Safe Application Debugger
  - Runtime Application Patcher
  - Kernel dump analysis tool
  - Latency Measurement Tool

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## Summary

- HA solutions are being built on COTS solutions today
- Telecommunications is the fastest growing HA sector using embedded Linux
- HA solutions require features for:
  - Availability
  - Scalability and Performance
  - Serviceability
  - Standards
- Linux is ready for HA Today

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THANK YOU

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